conical, electrically-conductive tubes **52** and **54**, symmetrically disposed about the central axis Z with their larger ends lying outside the quadrupole adjacent to the ion source and with their smaller ends lying inside the quadrupole in a plane containing the focal point *f* of the ion beam. Inner tube **52** is supported by an annular flange **55** of electrode **38** and is operated at the same negative voltage $-E_3$ as electrode **38**. Thus, the ion beam from the ion source is shielded from the fringing fields near the entrance of the quadrupole until it reaches a region inside the quadrupole and close to the central axis Z where the defocusing effect of the fringing fields is substantially reduced. Ions leaving the inner tube have a greater axial velocity than they have further inside the quadrupole. This minimizes their exposure to the fringing fields inside the quadrupole and to the higher order perturbations of the quadrupolar fringing fields produced by the high negative potential on the inner tube.

Outer tube **54** is insulatingly supported out of contact with inner tube **52** and is operated at quadrupole ground. This shields the quadrupole from the inner tube and thereby minimizes the perturbing effect of the inner tube upon the fields inside the quadrupole. The above-described fringing-field penetrating structure may improve the ion transmission efficiency and hence the sensitivity of the quadrupole mass filter by as much as one or two orders of magnitude. For greatest effectiveness the ion source and the conical tubes **52** and **54** should be designed to inject an ion beam of the highest possible density through the fringing fields to the furthest possible point on the central axis Z inside the quadrupole that can be reached without degrading the resolution of the quadrupole.

An ion detector **56**, such as a conventional electron multiplier or Faraday cup is mounted at the other end of housing **10** and is symmetrically disposed about the central axis Z. Positive ions entering and traversing the quadrupole impinge upon ion detector **56** and thereby produce an electrical current that may be measured by a conventional measuring and recording circuit **58**. The DC excitation voltage component $-U$ applied to the Y-rods also has a defocusing effect in the Y–Z plane upon the positive ions approaching and leaving the exit of the quadrupole. A fringing-field compensating structure similar to that described in a copending patent application entitled QUADRUPOLE MASS FILTER WITH ELECTRODE STRUCTURE FOR FRINGING-FIELD COMPENSATION and filed on or about June 19, 1968 by Edward F. Barnett, Donald L. Hammond and William S.W. Tandler may be disposed along the central axis between the exit of the quadrupole and the detector **56** to compensate for this defocusing effect and thereby further increase the ion transmission efficiency and hence the sensitivity of the quadrupole mass spectrometer. This structure comprises a pair of cylindrical electrodes **60** and **62**. The electrode **60** nearest the exit of the quadrupole is operated at quadrupole ground, and the electrode **62** nearest the ion detector is operated at a negative DC voltage $-U'$ referred to quadrupole ground and maintained directly proportional to the DC excitation voltage component U applied to the quadrupole.

We claim:

1. A multipole mass filter comprising:

a plurality of substantially parallel primary electrodes spaced symmetrically about a central axis and provided with terminal means for receiving an excitation voltage including AC and DC components balanced with respect to a reference potential to produce alternating and static multipole electric field components in the central region between the primary electrodes; and

a tubular electrode disposed about the central axis adjacent to one end of the primary electrodes, said tubular electrode being positioned with one end lying outside the central region between the primary electrodes and with the other end lying inside the central region between the primary electrodes.

2. A multipole mass filter as in claim **1** including another tubular electrode at least partially enclosing the first-mentioned tubular electrode, said tubular electrodes being conically shaped and concentrically mounted about the central axis for operating at different potentials with their larger openings lying outside the central region between the primary electrodes and with their smaller openings lying inside the central region between the primary electrodes.

3. A multipole mass filter as in claim **2** including means positioned near the larger opening of the inner conical tubular electrode for focusing a beam of ions at a region along the central axis near the smaller opening of the inner conical tubular electrode.

4. A quadrupole mass filter as in claim **3** wherein said last-mentioned means comprises an ion source for focusing the ion beam at a point on the central axis inside the quadrupole where the defocusing effect of the multipole electric field components is substantially reduced.

5. A quadrupole mass filter as in claim **4** wherein the smaller openings of the inner and outer conical tubular electrodes lie in a plane normally intersecting the central axis substantially at the focal point of the ion beam from the ion source.

6. A quadrupole mass filter as in claim **5** wherein the inner conical tubular electrode is operated at a potential of greater magnitude than both the outer conical tubular electrode and the ion source and of a sign for accelerating ions to a higher axial velocity within the inner conical tubular electrode than they have further inside the quadrupole.

7. A quadrupole mass filter as in claim **1** wherein said tubular electrode is conically shaped and concentrically mounted about the central axis with its larger opening lying outside the central region between the primary electrodes and with its smaller opening lying inside the central region between the primary electrodes.

8. A multipole mass filter as in claim **1** including an ion source positioned adjacent to said one end of the tubular electrode for focusing a beam of ions at a region along the central axis adjacent to said other end of the tubular electrode.

9. A multipole mass filter as in claim **1** including another tubular electrode disposed adjacent to said first-mentioned tubular electrode, said tubular electrodes being concentrically mounted about the central axis for operating at different potentials.

10. A multipole mass filter as in claim **9** wherein one of said tubular electrodes is operated at said reference potential and the other of said tubular electrodes is operated at a negative potential referred to said reference potential.

11. A multipole mass filter as in claim **10** wherein said last-mentioned tubular electrode at least partially encloses said first-mentioned tubular electrode.

12. A quadrupole mass filter as in claim **10** including:

an ion source positioned adjacent to said one end of said first-mentioned tubular electrode for focusing a beam of ions at a region along the central axis adjacent to said other end of the first-mentioned tubular electrode; and

an ion detector disposed along the central axis adjacent to the other end of the primary electrodes.

13. A quadrupole mass filter as in claim **12** wherein said tubular electrodes are concentrically disposed about the central axis adjacent to said one end of the primary electrodes, each of said tubular electrodes being positioned with one end lying outside the central region between the primary electrodes and with the other end lying inside the central region between the primary electrodes.